I. C. 6963

October 1937

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

MINING METHODS AND COSTS OF THE QUARTZ HILL MINING CO., DEWEY, MONT.

BY

S. H. LORAIN

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MINING METHODS AND COSTS
OF THE QUARTZ HILL MINING CO., DEWEY, MONT.[1]

By S. H. Lorain[2]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6963."

[2] Mining engineer, Metal Mining Methods Section, Mining Division, U. S. Bureau of Mines.

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INTRODUCTION

This paper is one of a series on mining methods and costs being published by the U. S. Bureau of Mines.

The operations of the Quartz Hill Mining Co., near Dewey, Mont., afford an interesting example of the cost of mining small bodies of direct shipping ore; they also illustrate the effect of the unavoidable periods of unusually high exploration and development costs in this type of mining upon the cost per ton of producing ore. The importance of skilled geological guidance and the necessity of avoiding unnecessary overhead and capital expense at small mines are shown.

Operating conditions at Quartz Hill are typical of those in many other mining districts of southwestern Montana. It is believed that the costs presented here may be of value in the preliminary estimation of costs to be expected by conservative operators under similar conditions elsewhere. The information contained in this paper was obtained during a visit to the Quartz Hill mine in August 1936.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to A. V. Taylor Jr.3/, who contributed generously of his time in supplying and checking the data from which this paper was written, and to Selden S. Rodgers4/, Anaconda, Mont., who supplied the historical data and added much to the value of the paper by his constructive suggestions.

3/ Superintendent, Quartz Hill Mining Co.
4/ Vice president and general manager, Quartz Hill Mining Co.

LOCATION AND ACCESSIBILITY

The Quartz Hill mines are in the Vipond mining district, Beaverhead County, Montana, 37 miles by road southwest of Butte and 6 miles southwest of Dewey; the post office address is Divide.

The nearest railroad point is at Divide, Mont., a small town on U. S. Highway 91, 24 miles from Butte. The mine is reached from Divide by an excellent graveled highway that follows the valley of the Big Hole River 6.6 miles to Dewey, and thence by a good mountain road up Quartz Hill Gulch to the mine.

The only heavy grades encountered between Butte and the mines are on the Quartz Hill Gulch road that climbs from an altitude of about 5,700 feet at Dewey to 7,700 feet at the mine.

Quartz Hill is in a well timbered area of the Beaverhead National Forest where timber needed for mining purposes may be obtained readily.

The climate is semiarid, but, in common with other mountainous sections of western Montana, there are occasional summer showers and winter snows attain considerable depths. It is usually possible to keep the road open for winter hauling except during severe storms.

The small drainage basin in which the camp is situated contains no permanent streams. Water is piped from a spring 4 miles distant; in winter the pipe line frequently freezes and water is hauled in barrels from Dewey.

HISTORY

The ore deposits on Quartz Hill were discovered in the 1860's and were first described by Raymond.[5]

In the early days a large amount of rich float ore was picked up on the surface and shipped by ox-team to Corinne, Utah, where it was transshipped to Swansea, Wales. From this originated the name "Quartz Hill."

By the late 1880's there were three panamalgamation mills at Dewey treating Quartz Hill ore. One of these was owned by the Jay Hawk Mining Co., one by the Lone Pine Mining & Milling Co., and the other by the Leggat family.

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[5] Raymond, Rossiter W., Silver and Gold; an Account of the Mining and Metallurgical Industry of the United States: J. B. Ford & Co., New York, 1873, p. 271.

In 1891 the Lone Pine and Jay Hawk companies were consolidated as the Jay Hawk & Lone Pine Consolidated Mining Co., Ltd., an English corporation, which built a new and larger panamalgamation mill at Quartz Hill to replace the mills at Dewey. The Quartz Hill camp was named Ponsonby, after Lord Ponsonby, president of the company.

Ore for the new mill came mainly from the Lone Pine ore body, which is said to have been mined to a depth of 1,800 feet on the dip. The old stopes are now caved and there is no accurate record of production. Some ore was also mined from rich fissure veins on Quartz Hill and from lenses in a black phosphatic limestone that overlies the 100 feet of shale forming the hanging wall of the Lone Pine and West Lone Pine ore bodies.

The panic of 1893 and declining silver prices was followed in 1895 by exhaustion of the Lone Pine ore shoot and cessation of operations.

In 1908 the Benton Mining & Milling Co. made use of a shaft on the Argyle fissure vein and produced ore for direct shipment to the smelter. This company was succeeded by the Argyle Silver Mining Co. which acquired the Argyle group of claims and a three-quarter interest in the Jay Hawk & Lone Pine Consolidated holdings. No mining was done by this company.

In January 1928 the Quartz Hill Mining Co. acquired the interests of the Argyle Silver Mining Co., the remaining one-quarter interest in the Jay Hawk & Lone Pine Consolidated, and other patented claims on Quartz Hill, thus bringing practically all claims on the hill under one ownership.

The Lone Pine shaft was reopened for examination. On the recommendation of a geologist, a drift was driven westward along the lime-shale contact; this picked up the upper part of the West Lone Pine ore body. Although the first ore encountered was low-grade, a winze developed good shipping ore below the 400-foot level.

Mine production started in August 1933, and, except for a short interruption in 1934, when the Anaconda smelter was closed by a strike, has been continuous ever since.

GEOLOGY

The ore deposits on Quartz Hill are found on the crest and flanks of a gently pitching anticline in Paleozoic shales and limestones that are part of a large roof pendant near the southern end of the Boulder batholith.

The crest of Quartz Hill ridge follows the axis of the anticlinal fold. On this crest, until it pitches southward below the bottom of Quartz Hill Gulch, the shales that comprise the upper stratigraphic member are eroded and expose the limestone. On the east and west flanks of the ridge, the shale-limestone contact dips rapidly beneath the surface (fig. 1).

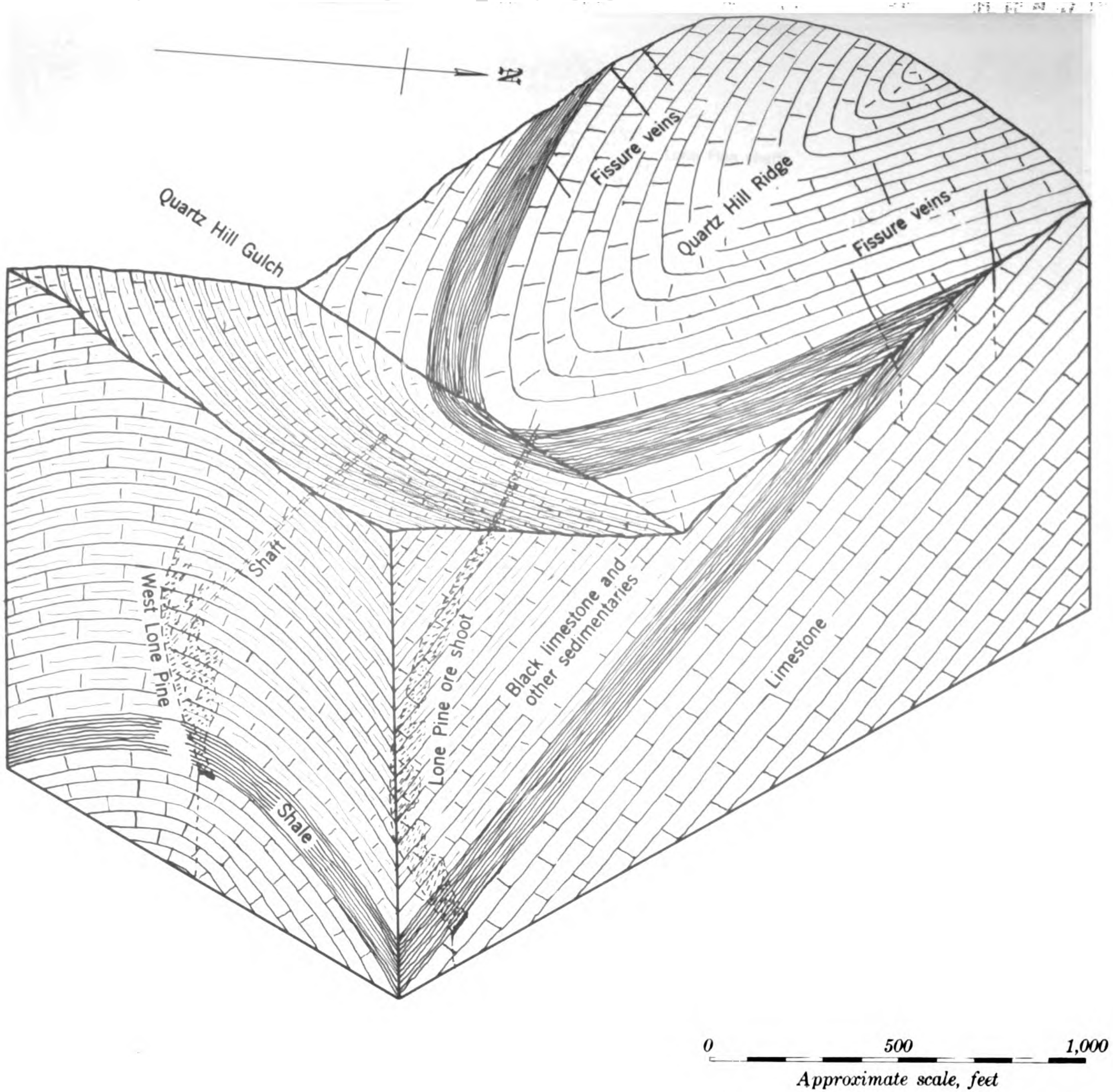

Figure 1.—Stereogram illustrating mode of occurrence of oreshoots at Quartz Hill.

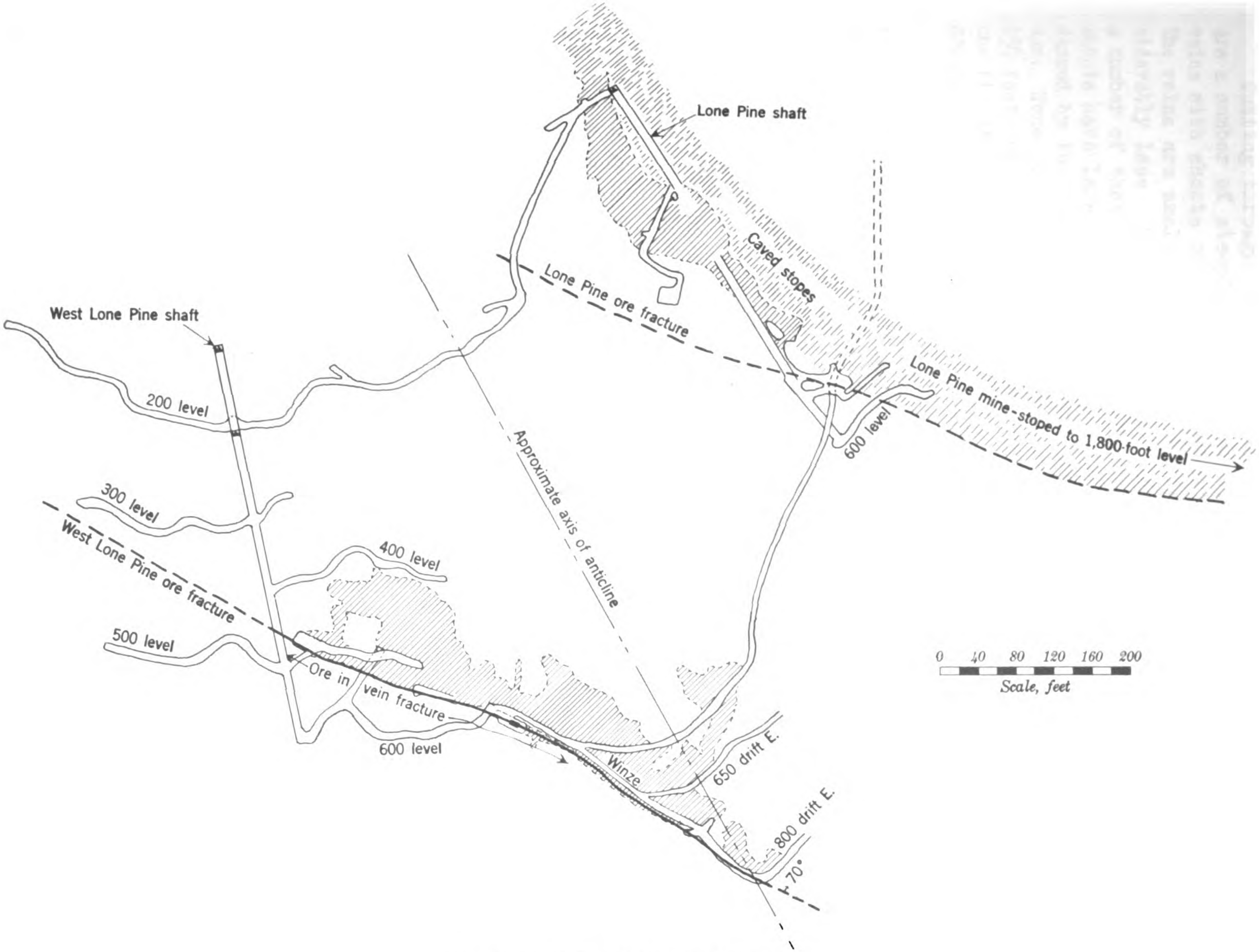

Figure 2.– Lone Pine and West Lone Pine mines.

Cutting through the limestone but terminating upward against the shales are a number of steeply dipping fractures, which frequently contain quartz veins with shoots of rich silver ore. The fractures are strong and persistent. The veins are small, attaining a maximum width of 5 feet but averaging considerably less. On the ridge near the eroded outcrop of the lime-shale contact a number of these fissure veins have been exposed at the surface and the ore shoots have largely been worked out. Apparently, the ascending solutions were dammed by the shales, forming ore shoots for only a short distance below the dam. None of the ore shoots so far explored continue downward more than 150 feet below the contact; however, the management hopes to explore at least one fissure to a depth sufficient to determine whether or not others occur at greater depth.

Only the Lone Pine and West Lone Pine fissures have been explored longitudinally for any great distance along the lime-shale contact. On each of these fissures a long, irregular, replacement ore body has been developed (fig. 2). These ore bodies are found only in the limestone immediately beneath the shale; they appear to bear a definite relation to ore shoots in the fissure veins. Apparently, the ore-bearing solutions spread out beneath the contact, replacing and mineralizing the limestone to form bedded deposits at the same time the vertical ore shoots of the fissure vein type were formed. The bedded ore bodies average from 2 to 4 feet thick. They dip about 30° and conform to the limestone beds.

Other vein fractures, known as the Aurora, Great Western, Partridge, and Pettingill, have produced rich ore from fissure veins in the limestone where exposed by erosion of the overlying shale. None of these fractures have been explored beneath the shale. It is believed that much of the float ore shipped in the early days was the eroded remnants of bedded deposits originally associated with these veins. There is, therefore, some reason to believe that ore bodies similar to the Lone Pine and West Lone Pine may be developed by longitudinal exploration beneath the shale where it overlies other vein fractures.

Silver is the only commercial metal; the only important sulphide mineral is freibergite, the silver-bearing variety of tetrahedrite. The gangue is quartz, calcite, barite, and possibly, some alunite.

The ore averaged 0.3 percent copper in 1935, all present in the tetrahedrite. This is not sufficient to be paid for in a direct-shipping ore but might yield some revenue in a concentrate. Ore shipments, which are diluted by about 5 percent $CaCO_3$ from the limestone walls, average 70 percent SiO2.

Ore shipments for 1935 averaged 25.04 ounces of silver per ton. In August 1936, when nearly all production was coming from the lowest levels, the average was 36.95 ounces, indicating an increasing silver content with depth in the West Lone Pine deposit.

No permanent water has yet been encountered in the deepest workings; the sulphides are oxidized to some extent at all levels.

METHODS OF DEVELOPMENT, EXPLORATION, AND MINING

Development and Exploration

The West Lone Pine mine is developed by a 5- by 8-foot inclined shaft 575 feet deep on the incline. The first 200 feet is at an angle of 60°, the remaining 375 feet at 30°. Beginning at the 200-foot level, stations were cut at 100-foot intervals along this incline and drifts driven to the limits of ore indications.

Above the 400 level only occasional bunches of commercial ore were found. At the 600-foot level the ore bodies had swung so far away from the shaft that an excessive amount of drifting would have been required to reach the ore. Consequently, a 15° to 20° inclined winze was driven along the ore fracture from the 600- to the 800-foot level. Short drifts were driven at 50-foot intervals along the slope of the incline to the ore limits. The winze is being continued along the vein fracture down the eastern flank of the anticline.

The ground between the Lone Pine and West Lone Pine has been explored by two drifts (fig. 2). The 200-level drift was driven from the Lone Pine westward. It was this drift that picked up the West Lone Pine ore shoot. The 600-level drift was driven primarily to connect with the Lone Pine shaft for ventilation and safety. It is being continued northward along the contact as an exploratory drift, as indicated by dotted lines in figure 2.

A considerable amount of exploratory work is also being done on the Aurora, Great Western, Partridge, and Pettingill veins. Although no bedded deposits have yet been discovered adjacent to these veins, some ore shoots of the fissure-vein type have been developed.

Development Details

Drifting and Sinking

Drifts are driven about 5 by 7 feet in cross section. Average advance is 4.2 feet per round of 12 holes. Either a "V" or "toe" cut is used, depending on the ground. Powder consumption in drifting is 2 pounds per ton broken, or 6.7 pounds per foot advanced.

Drifting usually is done on contract, at a rate of $4 per foot for labor only. Direct drifting cost, exclusive of power, averages as follows:

	Per foot
Labor......	$4.00
Powder.....	1.17
Caps.......	.04
Fuse.......	.15
Total....	5.36

The winze is driven 6 by 8 feet in cross section. Rounds 3.5 to 4 feet deep are broken with 10 to 14 holes. Powder consumption is 1.2 pounds per ton broken, or approximately 6 pounds per foot advanced. Sinking is carried on intermittently by men normally engaged on other work; consequently sinking costs are not kept.

Drifts are untimbered. Winzes are timbered only in so far as is necessary for the support of rails, sheaves, or an occasional piece of loose hanging wall.

Mining

Prior to August 1936, practically all recent production had been obtained from the West Lone Pine mine. Therefore, the mining methods described will be confined to that operation.

Stoping usually is by open-stope, overhand methods. The back is supported by irregularly spaced stulls with headboards. Pillars are left only where the ore is too low-grade to work. One small underhand stope was being worked to a depth of 50 feet in a quartz fissure vein in the West Lone Pine fracture, where the ore was 3 feet wide.

No chutes are built. Development raises are not driven but a narrow section of stope may be driven through to the next higher level if ventilation or access is desired.

Stoping is begun from the side of the drift and follows the irregular outline of the ore upward. Stopes are flat, usually under 35°; consequently, ore must be shoveled or scraped to the drift, where it is usually loaded into cars by hand. When a stope face has advanced a sufficient distance from the drift, a small mechanical scraper is installed. The scraper hoist is a converted "tugger" air hoist provided with a dividing flange in the middle of the drum. Cables are wound in opposite directions on the two halves of the drum. This hoist will function satisfactorily for scraping distances up to 100 feet. A scraping capacity of 17 tons in 2 hours from a distance of 75 feet has been recorded. The scraper has been found to have no advantage over hand mucking at distances less than about 20 feet.

Miners do their own timbering, mucking, and tramming. The tonnages and distances involved are insufficient to warrant a division of labor for these operations.

Stope rounds in the bedded ore bodies are usually drilled with mounted drifters, although self-rotated stopers and hand-held jack-hammers are used where the ore is too thin to permit a drifter to be set up conveniently. The depth and spacing of holes is varied from round to round to suit conditions in the irregular ore bodies.

One-inch, quarter octagon steel, without lugs, is used in both drifters and stopes. Timken detachable bits are used throughout; bit gauges start at 2 inches.

Powder consumption in overhand stopes ranges from 0.85 pound per ton in comparatively soft ground, to about 1.5 pounds per ton in harder ground.

Powder consumption was 2.15 pounds per ton of ore broken in the small underhand stope on the West Lone Pine fissure.

Underground Transportation

All ore is loaded in cars and trammed to the shaft or winze by the miners. Ore from below the 600-foot level is hoisted up the winze in cars, trammed to the shaft, and dumped directly into the skip by the winze hoistman.

Ore is hoisted in the main shaft in a 1-ton skip traveling at a rope speed of 500 feet per minute. The skip dumps on a 1-inch grizzly above an ore bin built into the surface headframe.

SORTING

Waste is sorted out on the grizzly, where between 10 and 12 percent of the material hoisted is eliminated. Sorting is done by the blacksmith and hoistman in their spare time. If more than 25 tons per shift is hoisted an extra ore sorter is required.

TRUCKING AND SHIPPING

Ore is trucked (12 miles) to Divide, Mont., and shipped by rail direct to the smelter at Anaconda.

Trucking is done on contract, according to the schedule of rates given below. These rates include the purchase and maintenance of trucks, partial maintenance of roads not maintained by the State, and the loading and unloading of the ore.

Truck schedule

Tons per month	Per ton
400 to 600	$2.50
600 to 800	2.25
800 to 1,000	2.00
1,000 to 1,200	1.75
1,200 to 1,500	1.50
1,500 to 2,000	1.40
Over 2,000	1.25

Railroad rates from Divide to Anaconda are $0.82 per ton for ore valued at not more than $15 per ton; $1.02 per ton for ore valued at $16 to $20 per ton; and proportionately higher rates for increasing ore values. The distance by rail from Divide to Anaconda is 38 miles.

SMELTER CHARGES

The ore is shipped to the Anaconda smelter at Anaconda, Mont., where it bears the regular charges for siliceous ores. Ninety-five percent of the silver in the ore is paid for at $0.77 per ounce less $0.02 per ounce, with a minimum deduction of one ounce per ton.

LABOR

Labor distribution on August 28, 1936 follows:

West Lone Pine mine

16	miners (8 each shift)........................ at	$4.75
2	underground hoistmen - winze (1 each shift)	4.75
2	surface hoistmen - compressormen-ore sorters (1 each shift)..................	5.25
1	blacksmith - ore sorter....................	4.75
1	night shift boss...........................	5.50
1	foreman....................................	6.00
23		

Of the 16 miners, four (two each shift) were in the underhand stope; four were on development work; and the remainder were in the main stopes.

In addition to the above, seven men were employed on exploration and development of other veins.

Of the 30 men directly employed on mine labor and supervision, 19 were engaged on actual production and 11 on exploration and development.

At this time the mine was producing 20 tons daily, an average of approximately 1 ton per man employed on direct production. An examination of labor costs for other periods indicates that this rate of output had been maintained with considerable uniformity throughout the life of the mine.

As ore reserves get low there is a falling off in production and an increased number of men are used on exploration which is characteristic of this type of mining. This results in wide fluctuations in the output per man for all men employed. The daily rate of production has fluctuated between 20 and 40 tons. The number of men employed on exploration and development has varied considerably from period to period. The production per man shift for all direct labor has varied from 0.5 ton to about 1.2 tons.

Only two men - an assayer and a truck driver (general utility man) - are employed steadily on strictly outside work. The latter sometimes fills in in the mine. General supervision, office work, engineering, and geological work is handled by the superintendent. All other necessary outside work is performed by men hired temporarily for the particular job or by miners working overtime. This practice keeps nonproductive labor at a minimum and eliminates any tendency to build up an "outside" crew, which, on an operation of this size, might frequently be employed on unnecessary tasks.

POWER

The main shaft is equipped with a 54-inch-diameter, single-drum, electric hoist driven by a 52-horsepower induction motor.

Air is furnished by an Ingersoll Rand Imperial type XCB compressor, driven by a 125-horsepower induction motor. This provides 813 cubic feet of air per minute at an elevation of 7,700 feet. All drills and the West Lone Pine underground hoists are operated by air from this compressor.

In addition to the above, 30 horsepower is sold to a small local sawmill, which supplies lumber as needed, 5 horsepower is used for operating a bit grinder, 5 horsepower in the assay office, and 15 horsepower for lights and miscellaneous purposes in the mine and camp. The connected horsepower is summarized as follows:

	Horsepower
Compressor...........	125
Hoist...............	52
Sawmill..............	30
Bit grinder..........	5
Assay office.........	5
Miscellaneous........	15
Total connected....	232

Actual "demand" load, based on the three highest 15-minute peaks per month, has never exceeded 125 horsepower. Consumption of power varies from 27,000 to 26,000 kw.-hr. per month.

Power is purchased from the Montana Power Co. at a rate of $1 per month per horsepower of peak demand, plus a charge per kw.-hr. consumed. The latter charge is on a sliding scale, that depends upon the maximum demand load. The rate on a demand load of 125 horsepower is $0.008 per kw.-hr. consumed.

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DETACHABLE BITS

Detailed records of the use and consumption of detachable bits have been kept from month to month. The following records are for two representative months in 1936 - one a period of high production, the other a period of low production:

Month	Bits issued		Bits dulled		Bits sharpened		Bits discarded		Tons ore mined
	No.	Per ton	No.	Per ton	No.	Per ton	No.	Per ton	
March	5,320	4.41	3,335	2.75	2,749	2.26	380	0.31	1,215
June	2,437	4.24	2,138	3.71	1,990	3.46	509	.88	574
	7,757	4.33	5,473	3.06	4,739	2.64	889	.50	1,789

The tonnages given above do not include waste mined on exploration and development; therefore, they are not a perfectly true measure of bit service. The March figures should give a more nearly true measure than the June figures since very little development work was done during that month.

Approximately five bits were sharpened for each bit discarded, an average of 5 regrinds per bit. Regrinding cost $0.06 per bit.

As already stated, the ore is a highly silicified limestone containing small concentrations of calcite and barite. Nearly all development work outside the ore bodies is in a hard dolomitic limestone.

Bits are sharpened at the mine blacksmith shop with an Ingersoll Rand J-2 bit grinder. It is estimated that the blacksmith can sharpen 150 bits per day. During the two months for which figures are given, he was, however, required to sharpen an average of only 76.6 bits per shift worked. The remainder of his time was available for other work, chiefly ore sorting.

Ingersoll Rand L-5B emery wheels were first tried but wore out after grinding from 70 to 300 bits each. A change was then made to N5B wheels. These have ground an average of about 700 bits each.

Between 15 and 20 drill rods are broken per month. The break usually occurs near the threaded end.

Threads are worn out or damaged on an additional 30 to 35 rods. Great care is taken at all times to protect the threads; rods are never handled without having bits screwed on for protection.

EQUIPMENT

When the present company began operations in 1928, the property was equipped only with a 30-horsepower gasoline hoist. As development proceeded, a portable compressor was installed, a new headframe was erected, and engine house, blacksmith shop, and cabins were constructed. During the summer of 1935 an electric power line was built to connect with lines of the Montana Power Co., the present electric-driven hoist and compressor were installed, and additional cabins were built.

COST OF CONSTRUCTION

Roads

In order to reduce hauling costs, the road from the mine to Dewey was repaired and partly relocated in the summer of 1935. About 3-1/2 miles of road was repaired and 2-1/2 miles entirely rebuilt. A bulldozer and one man were rented from the U. S. Forest Service at $40.00 per day. Some unnecessary labor cost was incurred by hand clearing until it was found that the bulldozer could clear all timber up to 8 inches in diameter. After this the bulldozer and its driver, with two men were able to build 1,000 to 1,500 feet of road per day of open side hill construction; or about 300 to 400 feet per day in heavy growth or through heavy boulders.

The following tabulation gives the cost of road construction and repair:

Labor....................	$896
Supplies (mainly gas and oil)..........	569
Bulldozer rental and miscellaneous.....	586
	2,051

Power Lines

A new power line 3.8 miles long was built and 3.8 miles more was rebuilt. On that part of the line that was newly built, a right-of-way 40 feet wide was cleared, partly through heavy timber.

Construction was performed by the mine crew, under direction of the superintendent. Actual power-line construction was completed at a cost of slightly over $500 per mile, or about half the usual cost of new construction. This was accomplished mainly by the use of second-hand steel wire, crossarms, and insulators.

Total cost of power-line construction, acquisition of rights on old line, clearing right-of-way, purchase and installation of transformers, wiring of machinery, and camp wiring was:

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Labor..............	$3,570
Supplies...........	2,140
Miscellaneous[6].....	294
	6,005

An additional 1 mile of power line was built to workings on veins other than the West Lone Pine. The power is used for hoisting. The cost was as follows:

Labor......	$504
Supplies...	200
Total....	704

Pipe Lines

For distribution of air from the main compressor to outlying workings, 4,500 feet of 4-inch airline was built.

An important saving in cost of supplies was made by the use of old 4-inch boiler tubing instead of pipes. The tubing was purchased for 10 cents a foot; the sections were joined by welding and have made an entirely satisfactory pipe line. The line was built at a sufficient height above ground to prevent its being covered by winter snow, thus affording ready access in case of freezing. Drains are provided at all low points, however, and no trouble has been experienced from freezing. The following pipe line costs were obtained:

Supplies....	$883
Labor.......	623
	1,506

COST OF OPERATION

Costs of mining are given for three different periods in tables 1 to 3. Table 1 covers a 6-month period during which operations were fairly uniform, and practically all work was confined to the West Lone Pine. During half of this period the mine was operated by gasoline power on one shift only. Table 2 is for a month of high production and little development. Table 3 is for a month of low production during which a considerable amount of exploration was being done on veins other than the West Lone Pine.

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[6] Back payments of license on acquired section of line.

TABLE 1. - Operating costs for the 6-months period, July to December 1935

Dry tons mined - 4,867

	Per ton	
Mining:[1]		
Labor[2]	$4.54	
Supplies	1.82	
Miscellaneous[3]	.24	$6.60
Sampling and assaying:		
Labor	.16	
Supplies	.26	.42
Water-line repairs		.12
Camp and general miscellaneous:[4]		
Labor (including superintendence)	.28	
Supplies	.20	
Miscellaneous	.24	.72
Workmens compensation		.45
Total per ton		8.31

---

[1] Includes exploration.
[2] Includes superintendence and nonproductive overhead.
[3] Includes power.
[4] Includes all miscellaneous work around camp and all supplies or services not directly chargeable to other operations.

TABLE 2. - Operating costs for March 1936

Dry tons mined,	West Lone Pine....	1,181.82
	Aurora............	33.97
		1,215.79

	Per ton	
West Lone Pine		
Mining:[1]		
Labor[2]........	$3.67	
Supplies........	1.36	
Power........	.22	
Machinery repairs........	.08	
Miscellaneous........	.06	$5.39
Sampling and assaying:		
Labor........	.04	
Supplies........	.005	.05
Camp and general miscellaneous:[3]		
Labor[2]........	.15	
Supplies........	.12	
Miscellaneous........	.21	.48
Workmens compensation........		.30
		6.22
Other veins - Aurora		
Labor[2]........	.31	
Supplies........	.10	
Workmens compensation........	.03	.44
Total per ton........		6.66

---

[1] Includes exploration.
[2] Includes superintendence.
[3] Includes all miscellaneous work around camp and all supplies or services not directly chargeable to other operations.

TABLE 3. - Operating costs for June 1936

Dry tons mined, West Lone Pine	524.70
Great Western	49.90
	574.60

	Per ton	
West Lone Pine		
Mining:[1]		
Labor	$6.55	
Supplies	1.10	
Machine repairs	.10	
Power	.48	
Superintendence and nonproductive overhead	.49	$8.72
Sampling and assaying:		
Labor	.26	
Supplies	.03	.29
Camp and general miscellaneous:[2]		
Labor	.15	
Supplies	.26	
Miscellaneous[3]	.80	1.21
Workmens compensation		.52
Power line and road repairs		.05
		10.79
Other veins		
Mining:[4]		
Labor	2.10	
Supplies	1.50	
Power	.05	
Superintendence and nonproductive overhead	.33	3.98
Air-line construction:		
Labor	.72	
Supplies and welding	.42	1.14
Total per ton		15.91

1/ Includes exploration.

2/ Includes all miscellaneous work around camp and all supplies or services not directly chargeable to other operations.

3/ Includes $190 for patent survey.

4/ Exploration; production of ore incidental.

MILLING POSSIBILITIES

The advisability of constructing a mill has been considered from time to time. Several factors have influenced the decision of the management not to build.

Most important is the difficulty of blocking out sufficient ore to insure amortization of the mill within the assured life of the mine. As in nearly all small-tonnage operations, production has followed close on the heels of development.

The ore is not amenable to cyanidation. Because of the partial oxidation of the ore, tests have indicated a maximum possible recovery by flotation of 90 percent; there is no assurance, or even probability, that this recovery would be equaled in actual operation. When to the cost of milling and concentrate shipment and treatment is added the loss in tailings, the saving by milling over direct shipment is reduced to a point where the cost of mill construction would only be warranted by an assured reserve of several years supply of ore.

Furthermore, normal milling costs would be increased by the necessity of piping water from a considerable distance.